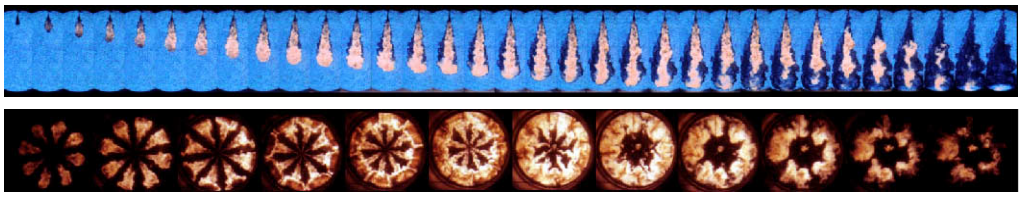
Combustion in Engines

Fact Sheet

Sandia National Laboratories' engine combustion department has had a close interaction with U.S. engine manufacturers for more than 20 years. Staff members promote the fundamental understanding of in-cylinder processes governing efficiency and emissions through the use of advanced, laser-based diagnostics.

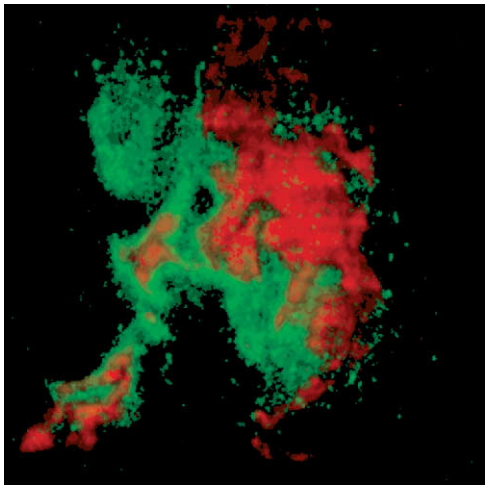
The CRF contains nine engine labs: three equipped with gasoline engines and six with diesel engines. Researchers use experimental hardware that closely mimics realistic engines while allowing optical access. All single-cylinder engines employ production or prototypical engine heads and are retrofitted with periscopes in exhaust valves, quartz cylinder heads, or windowed spacers between the piston liner and head to provide optical accessibility.



Diesel fuel ignition and combustion in the Sandia diesel simulation facility (top), and a heavy-duty diesel engine (bottom).

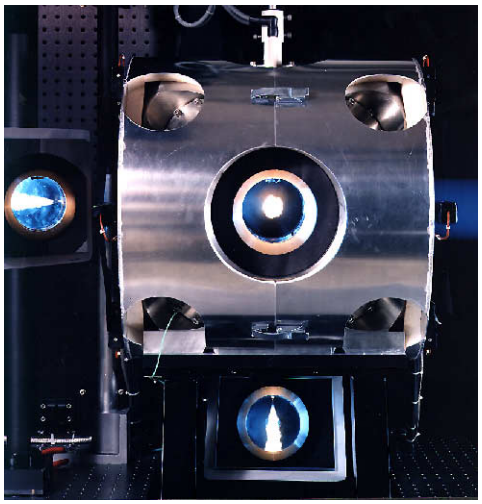
Heavy Duty Diesel Engines

Recognizing the need for a greater understanding of the diesel combustion process, considerable effort has been made to obtain detailed in-cylinder measurements. These studies have focused on learning where and when soot and NO_x form in the cylinder and have significantly improved understanding of diesel combustion.



Simultaneous images of OH radical (green) and soot (red) show the burnout process in an operating diesel engine.

A high-pressure diesel simulation facility enables a broad range of fuel injection conditions to be investigated. The goal of this work is to provide the manufacturers with a fundamental understanding of how fuel injection parameters affect the ignition and combustion process.



The high-pressure diesel simulation vessel in operation.

PNGV

The CRF is involved in the Partnership for a New Generation of Vehicles (PNGV), which is a

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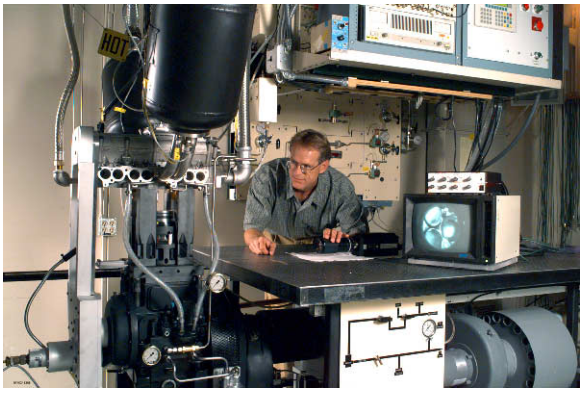
government/U.S. automaker partnership with the goal of producing an 80-mile-per-gallon automobile with a 400-mile cruising range. Representative projects are:

- An investigation of fuel injectors in a port-injected engine and their impact on combustion performance and emissions. The focus is on engine "cold starts" because this is when 60 to 70 percent of pollutants are exhausted.
- An examination of air and fuel mixing in direct-injection engines. This type of engine has fuel-saving potential but does not meet today's emissions standards.
- Research to better understand the in-cylinder processes governing efficient combustion and pollutant formation of a small-bore compression-ignition, direct-injection (diesel) engine.

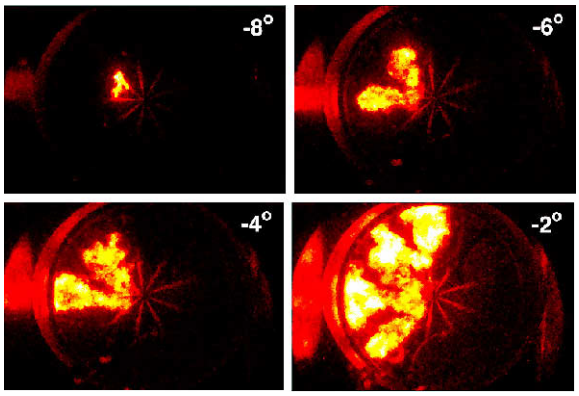


A Sandia researcher takes data from an optically accessible direct-injection gasoline engine.

Alternative Fuels

A desire for high-efficiency diesel engines that operate on alternative fuels or in a flexible-fuel mode has spawned a new research thrust and laboratory at the CRF. Currently, about a quarter of U.S. transportation-related energy use, and half of transportation particulate and NO_x emissions arise from heavy-duty transportation. In addition, heavy-duty transportation uses fuel that is primarily petroleum-based, and it is projected that it will consume ALL domestic petroleum production in the next ten years.

This research focuses on understanding the effects of various liquid fuels (e.g., bio-diesel, alcohols, and blends of these with diesel fuel) on diesel ignition, combustion, and emissions processes.



Early ignition and combustion of M85 (85% methanol, 15% diesel) fuel in an operating diesel engine.

Diesel Combustion Collaboratory

Meeting stringent new emissions regulations while maintaining or improving efficiency of diesel engines is a difficult challenge for manufacturers. The Diesel Combustion Collaboratory (DCC) is an innovative, information-sharing partnership that seeks to unite research efforts into more efficient and cleaner-burning diesel engines taking place at geographically disparate locations. Using modern computer and information science, the DCC is intended to increase the rate of information exchange and increase the use of computational models and visualization. The partnership involves Sandia, Lawrence, Livermore, Lawrence Berkeley, and Los Alamos national laboratories; Cummins Engine Company; Caterpillar, Inc.; Detroit Diesel Corporation; and the University of Wisconsin.

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